McGinley & Associates

425 Maestro Drive
Suite 202
Reno, NV 89511

ph: 775.829.2245
fax: 775.829.2213
www.mcgin.com

ATHENS ROAD WELL FIELD MODELING REPORT

Near BMI Industrial Complex
Henderson, Nevada

Prepared for:

Nevada Division of Environmental Protection
1771 East Flamingo Road
Suite121-A
Las Vegas, NV 89119

June 30, 2007

| Soil and Groundwater Remediation

| Regulatory Compliance

| Environmental Audits

| Hydrogeology

| Hazmat Response

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

This report describes the methods and results of an evaluation of the Athens Road groundwater extraction system, near the BMI Industrial Complex in Henderson, Nevada (Figure 1). The groundwater extraction system is designed to capture chromium and perchlorate plumes which are largely contained within paleochannel alluvial deposits underlain by fine grained sedimentary deposits. The purpose of the evaluation was to establish the degree of observed well field capture with respect to the target capture zone, and to develop an estimate of well field efficiency for mass recovery.

The majority of data used for this evaluation were provided by Tronox LLC and ~~it's~~ agents (Susan Crowley, Ed Krish, Bob Berry). Additional data were also contributed by Basic Remediation Company and it's agents.

1.1 Background

The history of perchlorate production at the BMI Industrial Complex has been summarized in several previous reports including Geraghty & Miller (1993) and NDEP (2003). Production of perchlorate compounds began within the BMI Industrial Complex in 1945. Initially, both the U.S. Navy and Western Electrochemical Company (WECCO) produced perchlorate compounds. In 1955, WECCO merged with American Potash and Chemical Company (AM&CC). The Navy ceased their operations in 1962 and sold that portion of the plant to AP&CC. Kerr-McGee purchased AP&CC in 1967 and continued perchlorate compound production until cessation of manufacturing in 1998. The remaining perchlorate compounds were recovered from the on-site lined ponds and process equipment, and the perchlorate production process was dismantled by March 2002.

High concentrations of perchlorate are found dissolved in groundwater on-site. The presence of the perchlorate is a result of past industrial activities which occurred over a large area of the alluvial fan above the Las Vegas Wash, specifically, the BMI Industrial Complex and the BMI Ponds. The BMI Industrial Complex is still active; however, use of the Ponds for the disposal of process effluent was discontinued in 1976.

Groundwater characterization efforts in the vicinity have identified two perchlorate plumes south of the Wash. One plume originates from the former Pacific Engineering & Production Company of Nevada (PEPCON) facility and extends northeasterly towards the Wash. The second plume originates from the Tronox LLC (formerly Kerr-McGee) facility within the BMI Industrial Complex and extends north-north easterly towards the Wash.

Active remediation measures are currently being conducted for the Tronox plumes at three areas: the on-site Interceptor well field, the Athens Road well field, and the Seep Area well field. This study focuses on evaluation of the Athens Road well field area.

1.1.1 Study Area Description

The study area encompasses the vicinity of the Athens Road well field (ARF), as shown in Figure 1. The ARF is situated approximately one and a half miles down-gradient of the on-site Interceptor well field. The City of Henderson aeration ponds and Rapid Infiltration Basins (RIBs) are situated approximately 400 feet and 1,700 feet, respectively, further north of the ARF. No faulting or structures are known to exist in the vicinity of the ARF.

Land surface generally slopes from the BMI Industrial Complex to the north toward the Las Vegas Wash with an approximate gradient of 0.020. Groundwater flows generally north towards the Wash under an approximate gradient of 0.010.

Groundwater flow across the ARF occurs primarily within somewhat defined alluvium-filled paleochannels. The paleochannels are incised into underlying lower permeability, fine grained Tertiary sedimentary deposits, which are widely accepted as Muddy Creek Formation (MCf). Quaternary alluvium comprised chiefly of gravels and sands with silt, overlie and fill the paleochannels. Chromium and perchlorate-impacted groundwater originating from the Tronox facility flows within a paleochannel which is further divided into two sub-channels with a higher mound of MCf separating them, in the immediate vicinity of the ARF.

1.1.2 Remediation History

A line of eight extraction wells across the divided paleochannel was installed at the ARF, and pumping and treatment of perchlorate-impacted groundwater was initiated in July 2002. However, the wells did not operate on a continuous basis until October 2002. A separate ion exchange system (IX) was installed and became operational in mid-October 2002, allowing for continuous operation of the ARF in conjunction with an existing IX used to treat collected seep water. A ninth well was installed during the second half of 2006. Currently seven "buddy well" pairs (closely spaced wells designed for dual redundancy of pumping and monitoring) operate on a continuous basis.

1.2 Objective and Scope of Services

The overall project objective was to qualify the effectiveness, and quantify the efficiency, of remedial activities currently being implemented at the ~~Athens Road well field~~ near the BMI Industrial Complex, Henderson, Nevada. To achieve that objective, four specific project tasks were defined, as follows:

1. Evaluate combined data sets (well construction and completion records, lithologic logs, water level and perchlorate concentration monitoring data, extraction well meter data, recent monitoring report exhibits, and a prior numerical model),
2. Generate a conceptual site model (CSM),
3. Perform an analog capture zone analysis, and
4. Generate a numerical model to calculate the efficiency of the Athens Road well field.

2. DATA SET AND CONCEPTUAL MODEL

A relatively large data set was compiled, including well construction and lithologic logs, survey data, water level measurements, groundwater sample analytical results, and extraction well meter readings. Approximately 250 monitoring or characterization locations were selected for regional database population (within an approximate one-mile radius of the ARF), with either water level or perchlorate concentration data, or both (Tables 1 and 2). A local domain was identified within closer proximity of the ARF, containing approximately seventy data locations for target data (Figure 2).

In the vicinity of Athens Road, groundwater is observed to be flowing generally towards the north-northeast under a moderately low hydraulic gradient, and towards the Seep area and the Las Vegas Wash. Static groundwater levels in the ARF area have been measured an average of 25 feet below ground surface (bgs), within Quaternary Alluvium (Qal). The Qal is underlain by the MCf at an average depth of 35 feet bgs. The paleochannel in the ARF area is defined by numerous lithologic logs in close proximity to the ARF (mostly ARP, ART and L series wells) and along Sunset Road (PC series wells), and by fewer logs at greater distance from the ARF.

The paleochannel topology at greater distances from the ARF is inferred based on the apparent correlation between calculated hydraulic conductivity from ART series wells, and paleochannel topology and perchlorate concentrations (plume geometry) in the ARF transect. Furthermore, the paleochannel appears to be separated into two sub-channels (west and east channel) with a ~~relative mound~~ of MCf materials between them, and pumping field conditions have decreased water levels below the ~~formations~~ contact in that immediate vicinity.

Given the large hydraulic conductivity contrast between the Qal and MCf, groundwater flow and solute transport are inferred to be largely dominant in the alluvium. However, some degree of communication is presumed to occur.

Large amounts of water are periodically infiltrated to the Qal at the City of Henderson RIBs, approximately 1,700 feet north of the ARF. Monitoring well hydrographs near the southeast corner of the RIBs indicate relatively large fluctuations in groundwater levels during the times of infiltration. However, monitoring wells closer to the ARF, near the lined aeration ponds indicate a far lesser degree of change, which may not be controlled by RIB infiltration (Figure 3). RIB infiltration is not considered hydraulically significant in the vicinity of the ARF.

3. METHODS OF ANALYSES

3.1 Analog Capture Zone Analysis

A preliminary two-dimensional capture zone analysis was conducted using tabulated and exhibited data from the report entitled *Semi-Annual Performance Report for Chromium and Perchlorate, Tronox LLC, Henderson, Nevada, July – December 2006* (Tronox, 2007). These data will be referred to as “second half 2006” herein; data from December 2006 was used where available.

Water level elevation data from monitoring wells within the ARF were plotted for examination. Gradients were calculated using the standard three-point solution for well triplets in close proximity, across the ARF. The calculation was performed using the U.S. Environmental Protection Agency (EPA) on-line site assessment tool, On-Site [http://www.epa.gov/athens/learn2model/part-two/onsite/gradient3ns.htm]. Vectors were plotted for each well triplet, and the resulting map was reviewed for indications of inward flow to the pumping well field. Perchlorate concentration data from monitoring wells within the area of interest were examined, as a secondary line of evidence.

3.2 Numerical Modeling

3.2.1 Numerical Codes

The codes selected for groundwater flow and solute transport modeling, respectively, were MODFLOW2000 and MT3D. The U.S. Geological Survey modular finite-difference ground-water flow model, MODFLOW2000 (Harbaugh et al., 2000) was used for the purpose of simulating groundwater flow. This code is the latest release of MODFLOW (McDonald and Harbaugh, 1988)~~, which is the most widely used program for simulating ground-water. The popularity of the program is attributed to the ease of understanding and use, and extensive model verification and documentation (Anderson and Woessner, 1992).~~ MODFLOW2000 will be referred to as MODFLOW herein. MODFLOW may be used to approximate the solution to the partial-differential equation for three-dimensional transient groundwater flow in heterogeneous and anisotropic media, assuming constant fluid density and alignment of the principal axes of hydraulic conductivity with the coordinate system (McDonald and Harbaugh, 1988; Harbaugh et al., 2000). MODFLOW is modular in structure: it uses a suite of subroutines for the solution of the groundwater flow problem and simulation of various hydrologic system components. ~~An in-depth treatment of the methods and applications of MODFLOW are readily available.~~

The PEST code (Watermark, 2004) was used to generate an independent model ~~of~~ hydraulic conductivity array. The PEST code perturbs each estimated parameter and records model calibration changes, in an iterative fashion, and tends towards parameter values that improve the model agreement with the target data. The use of PEST has a well documented history of successful use in solving groundwater problems along with MODFLOW-2000.

MT3D (Zheng, 1990) is a three-dimensional solute transport model for simulation of advection, dispersion and chemical reactions of contaminants in groundwater systems. MT3D was first developed by S.S. Papadopulos & Associates, Inc. with partial support from the U.S. Environmental Protection Agency (USEPA). Since 1990, MT3D has been available as a pubic domain code from the USEPA. MT3D is based on a modular structure to simulate solute transport. MT3D interfaces directly with MODFLOW for the head solution, and supports all the hydrologic and discretization features of MODFLOW. MT3D has been widely accepted and applied in numerous field-scale modeling studies throughout the world. ~~An in-depth treatment of the methods and applications of MT3D are readily available.~~

3.2.2 General Modeling Techniques

The groundwater flow model was run using the deterministic technique. The models were run as two-dimensional steady-state simulations, using site data for boundary conditions and pumping rates. The hydraulic conductivity array was developed using site data, professional judgment and ~~automated parameter estimation.~~

The preliminary solute transport model simulation time was set sufficiently long to generate essentially steady state conditions. Solute inputs for transport modeling were specified using site data and environmental interpretations. The solute transport model was not calibrated; however, final solute concentrations were found to be within acceptable ranges of observations for the purpose of this project.

3.2.3 Domain and Grid

The spatial dimensions of the model domain are shown on Figure 2. The spatial extents of the modeling domain were chosen to incorporate areas extending beyond the ARF area of influence. The southwest vertex of the model domain was chosen to coincide with the location of well PC-132 (Northing 26,726,723 feet, Easting 827,914 feet, State Plane Nevada East). The domain extends 2,600 feet north and 2,600 feet east form the southwest vertex. The northeast vertex of the model domain lies generally due north of the Athens Road/Pabco Road intersection, just north of a transect that includes the south-most lined aeration ponds.

The domain was discretized into a two-dimensional model grid with regular row and column spacing of 20 feet (130 rows and 130 columns; Figure 4). The grid spacing was chosen to provide sufficiently fine resolution to simulate flow nuances within the immediate vicinity of, and between, the extraction wells.

The bottom elevations of the model grid were calculated using site lithologic logs and a kriging method. The complete list of Qal-MCf contact elevations used for kriging is provided in Table 1, and a contour map of the model bottom is shown in Figure 5. The elevation of the top of the model is determined by calculation, since the aquifer is simulated as an unconfined aquifer.

3.2.4 Boundary Conditions

<u>Groundwater Flow Model</u>

A specified-head condition was used along the entire model boundary. The boundary head values were calculated using second half 2006 groundwater monitoring data and a kriging method. The complete list of groundwater elevations used for kriging is provided in Table 2, and a contour map of the groundwater elevations defining the boundary conditions is shown in Figure 6. Following initial model runs, a specified-flow boundary (no flow) was assigned to model cells within the Tronox-interpreted area of dewatered Qal and MCf between the sub-channels; this area is commonly referred to as “Muddy Creek high”.

Specified flow conditions were used to simulate pumping at the locations of ARF extraction wells. Extraction flow rate assignments were determined from average reported rates for 2005 and 2006, with the exception of wells ART-6 and ART-9 (Figure 8). ART-6 was not simulated for pumping, and the ART-9 pumping rate was designated based on the most recently reported pumping rates (39.5 gpm during first quarter 2007; personal communication, Todd Croft, NDEP). Simulated pumping rates are listed in Table 3.

<u>Preliminary Solute Transport Model</u>

Solute source concentrations were assigned to all cells along the southern (up-gradient) model boundary, and along a southern portion of the east boundary, based on the Tronox interpretation of perchlorate isopleths for the second half 2006 (Appendix A).

3.2.5 Aquifer Parameters

<u>Groundwater Flow Model</u>

The hydraulic conductivity array was developed using site data, professional judgment and automated parameter estimation. The initial hydraulic conductivity array was generated based on Tronox-provided values for each ARF extraction well, derived from pumping test conducted at the time of well construction (Table 3). Hydraulic conductivity zones were generated along the ARF transect based on the apparent direct correlation between historic and recent perchlorate concentrations for each extraction well, and Tronox-reported hydraulic conductivities (Appendix A, Table 3). Extrapolation of these zones to the north and south of the ARF transect was guided by the Qal-MCf contact surface and professional judgment. The final hydraulic conductivity array was calculated using parameter estimation, with target groundwater elevation data from second half 2007 (Figure 9).

<u>Preliminary Solute Transport Model</u>

A wide range of dispersivity values were tested, within expected ranges. The model appeared to be relatively insensitive to this parameter.

4. RESULTS OF ANALYSES AND MODELING

4.1 Analog Capture Zone Analysis Results

The results of the analog capture zone analysis are shown in Figure 10. Calculated groundwater gradient vectors do not indicate that capture was being achieved during the second half 2006.

4.2 Groundwater Flow

The results of parameter estimation for hydraulic conductivity are listed in Table 3. The difference between initial hydraulic conductivity values and the results of parameter estimation is relatively small (within low factors versus orders-of-magnitude). This result may be considered as a point of validation for modeled hydraulic conductivity, since the parameter estimation is based on observed groundwater elevations.

The groundwater flow model produced a mean absolute error (MAE) of 1.7 feet. The relative error, which is calculated by dividing the MAE by the total groundwater elevation relief throughout the model domain, was calculated to be approximately 4.2%. These degrees of error are deemed as low, and indicate a relatively high degree of performance for flow simulation, for the purpose of this project.

Initial model results indicated a limited degree of drying cells in the vicinity of ART-5. Drying cells were not produced throughout the entire area of the Muddy Creek high; however, the simulated saturated thickness in that area was relatively small. In order to preserve the effects of observed drying in that area, select cells were deactivated for subsequent model runs.

Initial model results appeared to indicate boundary effect (drawdown against a fixed head boundary, which may allow unlimited water input to the model) along a portion of the eastern model boundary. A boundary condition sensitivity test was performed by expanding the model boundary eastward by approximately 2,000 feet, and including data from the ~~AA~~ series of wells. The results of this testing showed less apparent boundary effect, and also resulted in extensive cell drying throughout the expanded model domain area. The initial boundary extents were re-incorporated for subsequent model runs; however the AA series data (Qal-MFc contact elevation and groundwater elevation data) were also included in model input kriging. Inclusion of these model components resulted in preserving the un-wrapped groundwater elevation contour results, without undue regional drying. The predicted groundwater elevation contours for the final flow model are shown in Figure 11.

A particle tracking exercise was performed using the results of the calibrated groundwater flow model (Figure 12). Two hundred and sixty particles were released uniformly along the southern model boundary. Some particles traveling along the western edge of the western sub-channel were simulated to pass the ARF extraction wells in that area; however, these particles were simulated to be deflected and captured by wells in the eastern sub-channel. All particles were captured using the final groundwater flow model.

4.3 Preliminary Solute Transport

The solute transport model was not strictly calibrated to observed perchlorate concentrations, and therefore serves only as a preliminary solute transport model. Despite the lack of calibration, calculated concentrations were generally simulated well within a factor of two compared with observed concentrations~~,~~ throughout the model domain.

The preliminary solute transport model results compare relatively well with observed concentration distributions through the western sub-channel (Figure 13). The results compare less ~~well~~ through the eastern sub-channel; specifically, the "tongue" of high concentrations extending through ARP-5 (264 mg/L) is not predicted by the preliminary transport model – the model predicts a high degree of capture through the eastern sub-channel. Concentrations in the vicinity of ARP-3 and ARP-4 are over-predicted.

Since the solute input concentrations were based generally on observed perchlorate concentrations, and the over-all concentration results generally agree with observed conditions, the mass budget for the solute transport model may be used for a limited calculation of ARF efficiency. A mass flux of 458 kg/day are simulated to be released into the model source boundary, approximately 456 kg/day are simulated to be extracted using the ARF, and approximately 2.2 kg/day (approximately 4.9 pounds per day) are simulated to escape the ARF. The mass balance calculations indicate the ARF to be 99.5% efficient, with 0.02% error.

5. DISCUSSION AND CONCLUSIONS

5.1 Primary Capture Zone Lines of Evidence

Industry-standard lines of evidence for plume capture include 1) potentiometric maps with sufficient contour detail to produce a reliable flow net, 2) inward flow demonstrated by hydraulic head data from appropriately located well pairs, and 3) decreasing temporal and spatial concentration data trends for key positioned wells.

The environmental interpretations presented for the second half 2006 (Appendix A, Plates 1 and 2) do not appear to demonstrate plume capture. The closed and inward-grading contour of 1590 feet above mean sea level (amsl) surrounding the ART series wells in the east sub-channel does not appear to be supported by plotted data; there are no data between the ART and ARP series wells through the east sub-channel to support the inclusion of that closed and inward graded contour. Neglecting the closed and inward graded 1590-foot contour, a flow net constructed on Plate 1 groundwater elevation contours does not result in flow paths that converge towards the ART wells. Also, none of the series of vectors based on well triplet groundwater elevation data across the ARF, from the analog capture zone analysis described herein, indicate inward flow. Recent groundwater elevation monitoring data do not indicate ARF capture is being achieved.

Perchlorate isopleth interpretations from second half 2006 appear to indicate relatively high concentrations extending down-gradient of the ART series wells, especially in the vicinity of ARP-5. Using a "ball-park" hydraulic conductivity value from the CSM (200 feet/day), an effective porosity of 0.20, and hydraulic gradient of 0.01, the average groundwater velocity in the vicinity of the paleochannel is estimated to be 10 feet/day. The elevated perchlorate concentration of 264 mg/L is shown for well ARP-5, which is located more than 300 feet down-gradient of the ART series wells in the east sub-channel. Given these calculations and observations, the center of a fresh water front which would be produced from complete ARF capture would have been anticipated to move past the position of ARP-5 within approximately 30 days of the commencement of pumping activities. A similar examination can be made for the west sub-channel. Perchlorate concentration data for key well positions do not appear to indicate complete ARF capture is being achieved.

The results of this analysis are not consistent with the results of the particle tracking exercise described above, which indicated that all particle pathways end at extraction well locations, and that "complete capture" is achieved.

5.2 Calculated Well Field Efficiency

In contrast to the inability to demonstrate plume capture using monitoring data and industry-standard methods, the preliminary solute transport model resulted in the prediction of a very high mass removal efficiency for the ARF. A similar degree of efficiency was also calculated for all preliminary models (previous to and during model refinement), indicating that the model's calculation of mass removal efficiency is generally insensitive to the main model elements, within their anticipated ranges. This observation appears to indicate that significant model performance gains are not possible for the current level of model complexity.

The high mass removal efficiency is due to more complete capture simulated for higher concentrations; only lower concentration groundwater is simulated to escape well field capture, due to dispersion along the plumes flanks and dispersion from higher concentration groundwater that passes by the western sub-channel and wraps towards the extraction wells of the eastern sub-channel.

The results of preliminary solute transport modeling are different, but not inconsistent, with the results of the particle tracking exercise described above. The different outcomes (complete capture for particle tracking versus incomplete capture for solute transport) stem from the inclusion of the effects of dispersion in the latter analysis, as described above.

The results of preliminary solute transport modeling are of limited use for site evaluation and decision support. The lack of well pairs to positively demonstrate capture impairs validation of the groundwater flow model, and hence any solute transport model (preliminary or otherwise). On the other hand, the high calculated efficiency for all stages of modeling suggests that high efficiency does actually exist, within the limitations of the CSM and ~~it's~~ implementation herein. Validation or qualification of the groundwater flow and preliminary solute transport model described herein is recommended prior to it's use for site evaluation and decision support. The disparity between observations and calculations presented herein underscores the need for model validation or further qualification.

6. RECOMMENDATIONS

Based on the results of analog capture zone analysis and numerical modeling described above, McGinley & Associates, Inc. provides the following recommendations:

1. ~~A~~dditional monitoring wells should be installed to support analog capture zone analysis, including nested or clustered wells for vertical definition, across the ARF,
2. a standard operating procedure (SOP) should be developed, outlining the procedures and rationale for routine capture zone analysis (analog or otherwise),
3. characterization should be performed on newly installed wells, including detailed lithologic logging and aquifer testing,

4. data obtained from new wells, or new data from existing wells, should be compared with the CSM and numerical models presented herein, in order to validate or qualify these models.

Example locations for additional wells are shown in Figure 14. The actual location of proposed wells should be thoroughly considered in order to maximize the degree of assurance that may be derived from routine capture zone analysis. A well within the ARF area of influence will not necessarily also demonstrate inward flow – the water level in that well must also be lower than that of down-gradient wells in order to support the assertion of inward flow.

Well pair data which support the assertion of inward flow, alone, do not necessarily demonstrate inward flow. Multiple lines of evidence are typically required before inward flow, and plume capture, may be asserted. Development of the ~~SOP~~ for routine capture zone analysis should consider widely available resources [e.g., http://www.epa.gov/tio/download/remed/rse/factsheet.pdf]

Significant additional investments to the current model set described herein are not recommended, at this time. MGA believes, barring additional data which contrast the current CSM, that the model set presented herein represented the system as well as possible, for the purpose of this project, and that no significant change to numerical model results will be produced from the inclusion of additional data, within expected ranges.

Additional modeling efforts beyond those described herein, pending the discovery of significantly different data, may include expanding the model to three dimensions (e.g., simulating interaction between Qal and MCf or the Muddy Creek transition zone). Also, calibration of the current solute transport model may be warranted in the case of modified project objectives (e.g., more precise evaluation of mass removal efficiency is deemed necessary).

7. REFERENCES

Anderson, M.P., and W.W. Woessner, 1992. Applied Groundwater Modeling: Simulation of Flow and Advective Transport. Academic Press, Inc.

Geraghty & Miller, 1993, Phase I Environmental Conditions Assessment for Basic Management, Inc., Industrial Complex, Clark County, Nevada, April.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 p.

McDonald, J.M., and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U.S. Geological Survey Techniques of Water Resources Investigations Book 6 Chapter A1, 586 pp.

Nevada Division of Environmental Protection, 2003, Fact Sheet – perchlorate in the Las Vegas Valley, NV, Significant Controls Are Operating, January.

Tronox, 2007. Semi-Annual Performance Report for Chromium and Perchlorate, Tronox LLC, Henderson, Nevada, July – December 2006. February 26, 2007.

Watermark Numerical Computing, 2004. PEST Model-Independent Parameter Estimation Software. Brisbane, Australia.

Zheng, C., 1990. MT3D: A modular three-dimensional transport model for simulation of advection, dispersion and chemical reactions of contaminants in ground-water systems, U.S. EPA, R.S. Kerr Environmental Research Laboratory, Ada, Oklahoma.

8. LIMITATIONS

The conclusions and recommendations presented herein are based, in part, on analytical data, field measurements, survey data and results of previous environmental assessment and/or remediation activities conducted by others. MGA makes no warranties or guarantees as to the accuracy or completeness of information provided or compiled by others. Changes in site conditions may occur as a result of rainfall, water usage, or other factors.

It should be recognized that definition and evaluation of environmental conditions is a difficult and inexact science. Judgments and opinions leading to conclusions and recommendations are generally made with an incomplete knowledge of the conditions present. More extensive studies, including additional environmental investigations, can tend to reduce the inherent uncertainties associated with such studies. Additional information not found or available to MGA at the time of writing this report may result in a modification to the conclusions and recommendations contained herein.

The presentation of data in plots presented herein is intended for the purpose of the visualization of environmental conditions. A greater degree of spatial and temporal data density may result in a more accurate representation of environmental conditions. Although such data visualization techniques may aid in providing a conceptual understanding of environmental conditions, such presentations are not intended to completely depict environmental conditions.

This report is not a legal opinion. The services performed by MGA have been conducted in a manner consistent with the level of care ordinarily exercised by members of our profession currently practicing under similar conditions. No other warranty, expressed or implied, is made.

9. CLOSING

MGA anticipates that the information provided herein satisfies the NDEP at this time. Please do not hesitate to call the Project Manager, at (775) 829-2245, with any questions or concerns.

Respectfully submitted,

McGinley and Associates, Inc.

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations, and ordinances.

The use of the word "certify" in this document constitutes an expression of professional opinion regarding those facts or findings which are the subject of the certification and does not constitute a warranty or guarantee, either expressed or implied.

Brian Giroux, P.G., C.Hg., C.E.M. #1742 Expires 6/21/2008
Project Manager

Reviewed by:

Joseph McGinley, P.G., P.E., C.E.M.
Principal

Cc: *T. Croft (NDEP, Las Vegas)*
B. Rakvica (NDEP, Las Vegas)
S. Harbour (NDEP, Las Vegas)
G. Lavato (NDEP, Carson City)
M. Kaplan (EPA, Region 9)
S. Crowley (Tronox)

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
AA-15	831754	26726004	BRC	Mon	1606.96
AA-19	832521	26727447	BRC	Mon	1575.34
AA-20	831812	26728008	BRC	Mon	1574.57
ARP-1	828593	26728366	Kerr-McGee	Monitor	1573.33
ARP-2	828726	26728364	Kerr-McGee	Monitor	1562.03
ARP-3	828861	26728365	Kerr-McGee	Monitor	1570.38
ARP-4	829172	26728364	Kerr-McGee	Monitor	1576.13
ARP-7	829668	26728501	Kerr-McGee	Monitor	1571.39
ART-1	828544	26728123	Kerr-McGee	Recovery	1562.57
ART-1A	828537	26728122	Kerr-McGee	Recovery	1561.80
ART-2	828625	26728085	Kerr-McGee	Recovery	1562.42
ART-2A	828619	26728086	Kerr-McGee	Recovery	1561.33
ART-3	828775	26728085	Kerr-McGee	Recovery	1574.18
ART-3A	828769	26728085	Kerr-McGee	Recovery	1566.14
ART-4	828851	26728085	Kerr-McGee	Recovery	1573.61
ART-4A	828844	26728085	Kerr-McGee	Recovery	1574.91
ART-5	829370	26728129	Kerr-McGee	Recovery	1589.18
ART-6	829473	26728141	Kerr-McGee	Recovery	1582.25
ART-6A	829479	26728141	Kerr-McGee	Recovery	1582.26
ART-8	828698	26728084	Kerr-McGee	Recovery	1567.54
ART-8A	828692	26728083	Kerr-McGee	Recovery	1566.53
ART-9	829526	26728143	Tronox	Recovery	1576.16
AZ-1	832810	26730277	Unknown	Monitor	1571.00
B-1	828418	26728050	Kerr-McGee	Boring	1577.52
B-2	828809	26728096	Kerr-McGee	Boring	1572.10
B-3	829210	26728103	Kerr-McGee	Boring	1592.42
B-4	829599	26728134	Kerr-McGee	Boring	1573.94
B-5	829210	26728071	Kerr-McGee	Boring	1595.01
B-6	829219	26728071	Kerr-McGee	Boring	1595.09
B-7	829448	26728078	Kerr-McGee	Boring	1584.06
B-8	829457	26728080	Kerr-McGee	Boring	1583.53
BEC-7	832696	26725924	BMI	Monitor	1615.32
BEC-9	833050	26727222	BMI	Monitor	1598.27
CMMW-1	824365	26728590	Unknown	Monitor	1588.00
DM-4	830802	26728131	COH/ D&M	Monitor	1597.43
DM-5	833187	26728699	COH/ D&M	Monitor	1600.82
DW-1	831874	26728426	Unknown	Monitor	1575.00
HMW-13	827711	26731740	COH	Monitor	1556.78
HMW-15	827608	26729901	COH	Monitor	1591.33
HMW-16	827090	26728531	COH	Monitor	1607.77
HSC-1	829167	26733118	COH	Boring	1503.00
HSC-2	830558	26733409	COH	Boring	1482.00
HSW-1	832121	26730001	COH	Monitor	1577.90
HSW-2	832608	26730008	COH	Monitor	1577.20
HSW-3	833120	26731276	COH	Monitor	1561.10

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
HSW-4	833677	26730298	COH	Monitor	1572.50
HSW-5	832558	26731059	COH	Monitor	1561.30
HSW-6	832832	26731107	COH	Monitor	1565.40
I-Z	828468	26719923	Kerr McGee	Recovery	1717.19
L-615	830280	26727857	EPA	Monitor	1597.40
L-617	830105	26727862	EPA	Monitor	1584.10
L-619	829913	26727855	EPA	Monitor	1587.50
L-621	829705	26727855	EPA	Monitor	1585.30
L-623	829535	26727856	EPA	Monitor	1583.10
L-625	829352	26727855	EPA	Monitor	1589.10
L-627	829147	26727855	EPA	Monitor	1591.70
L-629	828965	26727851	EPA	Monitor	1590.70
L-631	828744	26727841	EPA	Monitor	1575.00
L-631T	828697	26727747	EPA	Monitor	1567.80
L-633	828492	26727840	EPA	Monitor	1553.40
L-635	828302	26727839	EPA	Monitor	1588.27
L-637	828110	26727839	EPA	Monitor	1592.85
L-639	827906	26727838	EPA	Monitor	1594.50
L-641	827709	26727836	EPA	Monitor	1605.01
L-643	827511	26727836	EPA	Monitor	1608.30
L-643T	827473	26727731	EPA	Monitor	1605.60
L-645	827310	26727833	EPA	Monitor	1611.55
L-647	827106	26727830	EPA	Monitor	1604.80
L-649	826903	26727825	EPA	Monitor	1604.20
L-651	826709	26727828	EPA	Monitor	1612.63
L-653	826511	26727825	EPA	Monitor	1612.15
L-676	824195	26727815	EPA	Monitor	1602.10
LG-17	833420	26732683	USBR	Monitor	1506.00
LG-19	831713	26733098	USBR	Monitor	1507.00
LG-21	831480	26728495	USBR	Monitor	1583.00
LG-27	827263	26732993	USBR	Monitor	1530.61
LK-1	827207	26727861	DRI	Monitor	1604.77
LK-2	827202	26727869	DRI	Monitor	1603.83
LK-3	827212	26727870	DRI	Monitor	1605.72
LK-4	827216	26727863	DRI	Monitor	1600.78
LK-5	827401	26727857	DRI	Monitor	1602.47
LK-6	827410	26727848	DRI	Monitor	1612.24
M-17A	828062	26719054	Kerr McGee	Monitor	1724.95
M-31A	828368	26718290	Kerr McGee	Monitor	1753.94
MW-AJ	826455	26726030	AMPAC	Monitor	1625.30
MW-J	824962	26725010	AMPAC	Monitor	1647.76
MW-K4	828994	26728411	AMPAC	Monitor	1571.21
MW-K5	829617	26730252	AMPAC	Monitor	1557.62
MW-O	824197	26727965	AMPAC	Monitor	1605.33
MW-QD	826074	26727995	AMPAC	Monitor	1597.00
MW-QS	826074	26727995	AMPAC	Monitor	1597.00

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
MW-R	825423	26725016	AMPAC	Monitor	1645.72
MW-S	826941	26730853	AMPAC	Monitor	1564.02
MW-T	826645	26732347	AMPAC	Monitor	1553.02
MW-TWB-140	825090	26726489	AMPAC	Monitor	1634.87
MW-TWB-21	825254	26726461	AMPAC	Monitor	1630.57
MW-TWB-36	825066	26726470	AMPAC	Monitor	1634.70
MW-TWB-54	825080	26726478	AMPAC	Monitor	1634.86
MW-TWBX-21	825215	26726338	AMPAC	Monitor	1636.40
MW-TWBX-36	825224	26726346	AMPAC	Monitor	1639.06
MW-TWBY-21	824977	26726538	AMPAC	Monitor	1638.08
MW-TWBY-36	824988	26726540	AMPAC	Monitor	1634.79
MW-TWC-126	825286	26726687	AMPAC	Monitor	1634.57
MW-TWC-15	825244	26726761	AMPAC	Monitor	1633.47
MW-TWC-28	825252	26726747	AMPAC	Monitor	1634.16
MW-TWC-35	825270	26726726	AMPAC	Monitor	1634.30
MW-TWC-48	825263	26726714	AMPAC	Monitor	1633.49
MW-TWE-107	826428	26727637	AMPAC	Monitor	1611.95
MW-TWE-15	826426	26727677	AMPAC	Monitor	1619.86
MW-TWE-18	826427	26727666	AMPAC	Monitor	1610.66
MW-TWE-33	826427	26727656	AMPAC	Monitor	1617.68
MW-TWE-51	826427	26727647	AMPAC	Monitor	1595.76
PB-104	832612	26733397	Other	Boring	1528.30
PC-1	830925	26730309	Kerr McGee	Monitor	1565.68
PC-10	829891	26727968	Kerr McGee	Monitor	1585.33
PC-100R	829542	26730295	Kerr McGee	Monitor	1552.51
PC-101	828715	26728111	Kerr McGee	Monitor	1567.86
PC-101R	828712	26728108	Kerr McGee	Monitor	1567.28
PC-103	829111	26730206	Kerr McGee	Monitor	1568.02
PC-104	829277	26731050	Kerr McGee	Monitor	1561.68
PC-105	828827	26731426	Kerr McGee	Monitor	1541.27
PC-106	827110	26730248	Kerr McGee	Monitor	1569.10
PC-107	827136	26729288	Kerr McGee	Monitor	1601.19
PC-108	828527	26731913	Kerr McGee	Monitor	1539.96
PC-109	828117	26732064	Kerr McGee	Monitor	1552.21
PC-11	829542	26727966	Kerr McGee	Boring	1581.98
PC-111	826540	26732782	Kerr McGee	Monitor	1550.79
PC-112	828898	26732801	Kerr McGee	Monitor	1525.24
PC-113	829177	26732303	Kerr McGee	Monitor	1543.71
PC-114	829701	26732303	Kerr McGee	Monitor	1544.83
PC-115	831045	26733155	Kerr McGee	Monitor	1505.00
PC-115R	831149	26733131	Kerr McGee	Recovery	1504.79
PC-116	831365	26733213	Kerr McGee	Monitor	1505.50
PC-116R	831348	26733203	Kerr McGee	Recovery	1503.04
PC-117	831422	26733276	Kerr McGee	Recovery	1500.23
PC-118	831052	26733167	Kerr McGee	Recovery	1504.15
PC-119	830951	26733189	Kerr McGee	Recovery	1507.34

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
PC-12	829430	26728103	Kerr McGee	Monitor	1587.16
PC-120	830851	26733186	Kerr McGee	Recovery	1509.41
PC-122	829675	26728145	Kerr McGee	Monitor	1580.39
PC-123	829485	26727358	Kerr McGee	Monitor	1593.44
PC-124	830133	26726742	Kerr McGee	Monitor	1603.73
PC-125	829926	26726740	Kerr McGee	Monitor	1603.06
PC-127	829317	26726736	Kerr McGee	Monitor	1599.42
PC-128	828954	26726732	Kerr McGee	Monitor	1601.36
PC-13	829145	26728098	Kerr McGee	Boring	1588.89
PC-130	828538	26726729	Kerr McGee	Monitor	1585.21
PC-131	828123	26726725	Kerr McGee	Monitor	1593.58
PC-132	827914	26726723	Kerr McGee	Monitor	1602.84
PC-14	829037	26728096	Kerr McGee	Boring	1590.27
PC-15	828937	26728094	Kerr McGee	Boring	1580.29
PC-16	828837	26728091	Kerr McGee	Boring	1571.48
PC-17	828733	26728089	Kerr McGee	Monitor	1569.28
PC-18	828636	26728080	Kerr McGee	Monitor	1566.69
PC-19	828510	26728053	Kerr McGee	Monitor	1560.46
PC-2	830443	26730210	Kerr McGee	Monitor	1562.79
PC-20	828413	26728053	Kerr McGee	Boring	1577.36
PC-22	830321	26726737	Kerr McGee	Boring	1610.15
PC-23	829922	26726733	Kerr McGee	Boring	1606.62
PC-24	829524	26726730	Kerr McGee	Monitor	1605.95
PC-25	829124	26726727	Kerr McGee	Boring	1611.84
PC-27	829016	26725387	Kerr McGee	Boring	1624.46
PC-28	828531	26725376	Kerr McGee	Monitor	1633.17
PC-29	828014	26725373	Kerr McGee	Boring	1618.66
PC-3	830727	26730272	Kerr McGee	Boring	1566.53
PC-30	827269	26725198	Kerr McGee	Boring	1618.29
PC-31	826782	26725196	Kerr McGee	Monitor	1608.13
PC-32	826260	26725194	Kerr McGee	Boring	1620.96
PC-4	831172	26730353	Kerr McGee	Monitor	1553.63
PC-45	824003	26727056	Kerr McGee	Boring	1612.39
PC-46	824280	26726758	Kerr McGee	Boring	1614.65
PC-47	824593	26726430	Kerr McGee	Boring	1619.66
PC-48	824943	26726042	Kerr McGee	Boring	1622.68
PC-49	828727	26726726	Kerr McGee	Boring	1596.48
PC-5	830583	26730236	Kerr McGee	Boring	1568.49
PC-50	828327	26726722	Kerr McGee	Monitor	1590.99
PC-51	828027	26726719	Kerr McGee	Boring	1601.96
PC-52	830191	26730231	Kerr McGee	Boring	1560.10
PC-53	829942	26730225	Kerr McGee	Monitor	1561.14
PC-55	828530	26728057	Kerr McGee	Monitor	1565.95
PC-56	830645	26732289	Kerr McGee	Monitor	1516.99
PC-57	830831	26732239	Kerr McGee	Boring	1518.21
PC-58	831124	26732118	Kerr McGee	Monitor	1536.79

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
PC-59	830150	26732453	Kerr McGee	Monitor	1536.34
PC-6	831073	26730335	Kerr McGee	Boring	1556.84
PC-60	830405	26732359	Kerr McGee	Monitor	1529.80
PC-61	830525	26732323	Kerr McGee	Boring	1523.70
PC-62	829764	26732734	Kerr McGee	Monitor	1533.45
PC-63	829926	26732553	Kerr McGee	Boring	1533.95
PC-68	829617	26732907	Kerr McGee	Monitor	1517.66
PC-69	829478	26733074	Kerr McGee	Boring	1516.19
PC-7	831271	26730372	Kerr McGee	Boring	1556.92
PC-70	828700	26728085	Kerr McGee	Monitor	1566.27
PC-74	829204	26734004	Kerr McGee	Monitor	1508.54
PC-75	829195	26734005	Kerr McGee	Boring	1508.48
PC-76	829184	26734007	Kerr McGee	Monitor	1508.51
PC-79	829815	26733247	Kerr McGee	Monitor	1519.33
PC-8	831129	26730316	Kerr McGee	Boring	1556.68
PC-80	829824	26733250	Kerr McGee	Monitor	1519.07
PC-81	829833	26733255	Kerr McGee	Monitor	1519.03
PC-82	830317	26733195	Kerr McGee	Monitor	1503.44
PC-83	830326	26733201	Kerr McGee	Monitor	1503.47
PC-84	830333	26733209	Kerr McGee	Monitor	1503.14
PC-85	830816	26733186	Kerr McGee	Monitor	1506.70
PC-86	830827	26733186	Kerr McGee	Monitor	1507.08
PC-87	830838	26733185	Kerr McGee	Monitor	1507.09
PC-88	831259	26733178	Kerr McGee	Monitor	1499.91
PC-89	831265	26733184	Kerr McGee	Monitor	1499.90
PC-9	830329	26727966	Kerr McGee	Boring	1598.02
PC-90	831272	26733193	Kerr McGee	Monitor	1499.53
PC-91	831730	26733111	Kerr McGee	Monitor	1512.42
PC-92	831749	26733110	Kerr McGee	Monitor	1512.12
PC-93	832180	26733118	Kerr McGee	Monitor	1508.86
PC-94	832189	26733122	Kerr McGee	Monitor	1508.84
PC-95	831227	26733450	Kerr McGee	Monitor	1507.61
PC-96	830897	26733451	Kerr McGee	Monitor	1505.69
PC-97	831566	26733442	Kerr McGee	Monitor	1505.78
PC-98	829520	26730256	Kerr McGee	Monitor	1552.35
PC-98R	829523	26730261	Kerr McGee	Monitor	1552.96
PC-99R	831245	26733143	Kerr McGee	Monitor	1500.17
PC-99R2	831259	26733155	Kerr McGee	Recovery	1500.18
PC-99R3	831256	26733160	Kerr McGee	Recovery	1499.90
PG-101	824243	26725482	USBR	Monitor	1631.00
PG-109	824917	26727734	USBR	Monitor	1616.70
PG-110	826385	26727911	USBR	Monitor	1610.20
PG-208	829919	26725374	USBR	Monitor	1623.40
PG-209	830312	26725382	USBR	Monitor	1631.60
PG-210	830735	26725542	USBR	Monitor	1626.50
PG-211	831877	26725841	USBR	Monitor	1625.30

Table 1. Data Locations for Qal-MCf Contact (Model Bottom) Elevation Contouring

Well ID	Easting	Northing	Owner	Type	Qal-MCf
PG-212	830103	26727908	USBR	Monitor	1585.80
PG-213	830134	26728101	USBR	Monitor	1594.70
PG-214	830652	26727983	USBR	Monitor	1600.60
PG-222	832748	26725481	USBR	Monitor	1619.40
PG-224	828737	26730196	USBR	Monitor	1565.10
PG-225	831419	26730393	USBR	Monitor	1558.60
PG-226	828897	26731765	USBR	Monitor	1551.90
PG-227	830399	26731372	USBR	Monitor	1550.30
PG-228	830802	26731368	USBR	Monitor	1535.40
PG-229	830459	26732378	USBR	Monitor	1531.50
PG-230	828400	26732829	USBR	Monitor	1563.40
PG-231	832628	26728945	USBR	Monitor	1595.50
PG-232	833251	26729007	USBR	Monitor	1599.50
PG-233	833861	26728966	USBR	Monitor	1596.10
PG-235	826293	26725405	USBR	Monitor	1612.80
PG-237A	827249	26726757	USBR	Monitor	1615.10
PG-241	827674	26725964	USBR	Monitor	1613.20
PG-256	832118	26732045	USBR	Monitor	1546.10
PSW-6	827915	26727657	Other	Boring	1587.00
WW-1	825800	26727500	USBR	Boring	1622.00

Table 2. Data Locations for Groundwater Elevation Contouring

Well ID	Easting	Northing	TOC	Sample Date	Depth to Water	Elevation
AA-15	831754	26726004		17-Nov-06		1615.87
AA-19	832521	26727447		17-Nov-06		1599.85
AA-20	831812	26728008		17-Nov-06		1600.68
ARP-1	828593	26728366	1613.32	12-Dec-06	22.01	1591.31
ARP-2	828726	26728364	1612.79	12-Dec-06	21.85	1590.94
ARP-3	828861	26728365	1612.17	12-Dec-06	22.28	1589.89
ARP-4	829172	26728364	1613.01	12-Dec-06	24.11	1588.90
ARP-5	829395	26728453	1615.01	12-Dec-06	28.58	1586.43
ARP-6A	829515	26728480	1614.11	12-Dec-06	27.82	1586.29
ARP-7	829668	26728501	1613.20	12-Dec-06	26.88	1586.32
ART-1	828544	26728123	1614.47	11-Dec-06	29.99	1584.48
ART-1A	828537	26728122	1614.40	11-Dec-06	21.91	1592.49
ART-2	828625	26728085	1617.10	11-Dec-06	25.69	1591.41
ART-2A	828619	26728086	1616.81	11-Dec-06	24.74	1592.07
ART-3	828775	26728085	1617.94	11-Dec-06	27.37	1590.57
ART-3A	828769	26728085	1617.60	11-Dec-06	30.24	1587.36
ART-4	828851	26728085	1617.46	11-Dec-06	37.74	1579.72
ART-4A	828844	26728085	1617.46	11-Dec-06	26.73	1590.73
ART-5	829370	26728129	1614.06	11-Dec-06	25.63	1588.43
ART-6	829473	26728141	1615.31	11-Dec-06	27.72	1587.59
ART-7	829577	26728146	1615.38	11-Dec-06	28.22	1587.16
ART-7A	829583	26728143	1614.78	11-Dec-06	29.14	1585.64
ART-8	828698	26728084	1617.69	11-Dec-06	26.26	1591.43
ART-8A	828692	26728083	1617.10	11-Dec-06	27.73	1589.37
ART-9	829526	26728143	1615.06	11-Dec-06	28.46	1586.60
I-Z	828468	26719923	1743.78	01-Nov-06	34.00	1709.78
L-635	828302	26727839	1620.94	12-Dec-06	15.12	1605.82
L-637	828110	26727839	1621.60	12-Dec-06	10.41	1611.19
M-17A	828062	26719054	1768.99	15-Dec-06	33.11	1735.88
M-31A	828368	26718290	1796.87	15-Dec-06	46.37	1750.50
MW-K4	828994	26728411	1614.96	12-Dec-06	26.02	1588.94
MW-K5	829617	26730252	1598.87	12-Dec-06	26.11	1572.76
PC-101R	828712	26728108	1618.12	12-Dec-06	26.48	1591.64
PC-103	829111	26730206	1599.49	12-Dec-06	21.62	1577.87
PC-115R	831149	26733131	1554.71	11-Dec-06	10.92	1543.79
PC-116R	831348	26733203	1552.10	11-Dec-06	19.02	1533.08
PC-117	831422	26733276	1552.26	11-Dec-06	10.14	1542.12
PC-118	831052	26733167	1554.53	11-Dec-06	6.23	1548.30
PC-119	830951	26733189	1554.66	11-Dec-06	3.85	1550.81
PC-12	829430	26728103	1616.37	12-Dec-06	28.12	1588.25
PC-120	830851	26733186	1554.64	11-Dec-06	2.48	1552.16
PC-121	830751	26733180	1554.10	11-Dec-06	2.56	1551.54

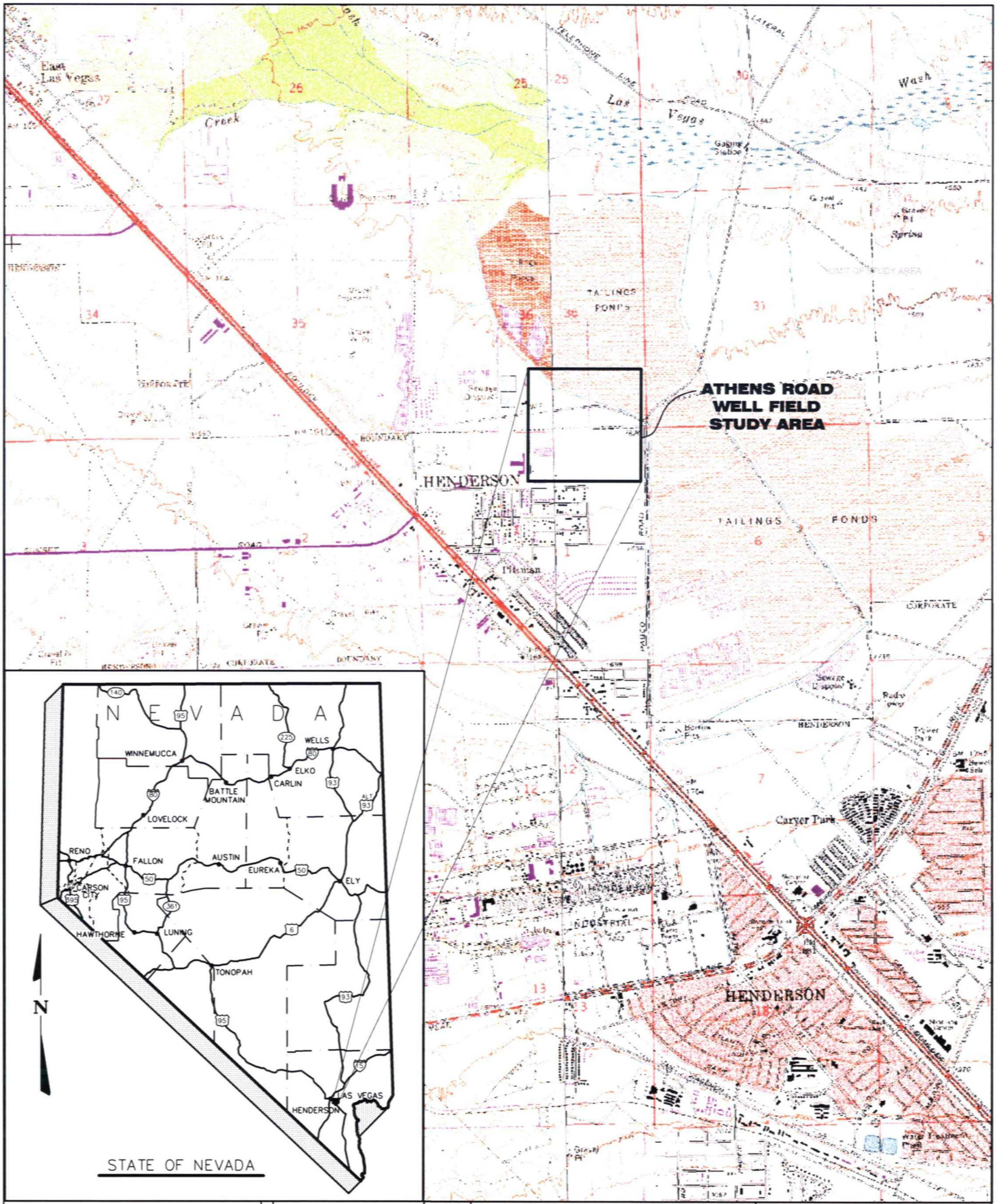
Table 2. Data Locations for Groundwater Elevation Contouring

Well ID	Easting	Northing	TOC	Sample Date	Depth to Water	Elevation
PC-122	829675	26728145	1617.39	12-Dec-06	29.58	1587.81
PC-123	829485	26727358	1626.44	30-Oct-06	23.00	1603.44
PC-124	830133	26726742	1635.73	30-Oct-06	24.90	1610.83
PC-125	829926	26726740	1635.06	30-Oct-06	23.45	1611.61
PC-126	829725	26726738	1634.33	30-Oct-06	22.45	1611.88
PC-127	829317	26726736	1632.42	30-Oct-06	19.21	1613.21
PC-128	828954	26726732	1633.36	30-Oct-06	18.48	1614.88
PC-129	828747	26726731	1633.99	30-Oct-06	18.55	1615.44
PC-130	828538	26726729	1633.21	30-Oct-06	19.10	1614.11
PC-131	828123	26726725	1633.58	30-Oct-06	11.10	1622.48
PC-132	827914	26726723	1634.84	30-Oct-06	9.87	1624.97
PC-133	831758	26733209	1553.00	11-Dec-06	5.33	1547.67
PC-17	828733	26728089	1617.00	12-Dec-06	25.37	1591.63
PC-18	828636	26728080	1618.47	12-Dec-06	26.42	1592.05
PC-53	829942	26730225	1595.03	12-Dec-06	22.71	1572.32
PC-55	828530	26728057	1617.19	12-Dec-06	24.25	1592.94
PC-56	830645	26732289	1568.25	12-Dec-06	8.46	1559.79
PC-58	831124	26732118	1567.96	12-Dec-06	7.83	1560.13
PC-59	830150	26732453	1567.92	12-Dec-06	9.24	1558.68
PC-60	830405	26732359	1568.38	12-Dec-06	8.42	1559.96
PC-62	829764	26732734	1567.83	12-Dec-06	9.71	1558.12
PC-68	829617	26732907	1566.97	12-Dec-06	8.48	1558.49
PC-86	830827	26733186	1553.85	12-Dec-06	2.74	1551.11
PC-90	831272	26733193	1550.46	12-Dec-06	4.28	1546.18
PC-91	831730	26733111	1552.33	12-Dec-06	7.31	1545.02
PC-95	831227	26733450	1550.62	12-Dec-06	4.03	1546.59
PC-97	831566	26733442	1548.53	12-Dec-06	3.29	1545.24
PC-98R	829523	26730261	1593.35	12-Dec-06	19.75	1573.60

Table 3. ART Well Pumping Rates, Perchlorate Concentrations, Reported and Calculated Hydraulic Conductivities

Well ID	FLOW1	FLOW2	Reported K	Early ClO4	Late ClO4	Initial K	Final K
ART-1	15.45753	2975.782	40	(75)	0.2	1: 40	1: 25
ART-2	70.73425	13617.29	278	(368)	125	4: 300	4: 238
ART-8	68.03973	13098.56	164	(386)	325	3: 150	3: 178
ART-3	32.50274	6257.212	53	(386-130)	431	2: 70	2: 25
ART-4	13.80822	2658.267	75	(130)	379	1: 40	1: 25
ART-5	-	-	-	(186)	74	3: 150	3: 178
ART-6	-	-	150	(186)	105	3: 150	3: 178
ART-9	39.6*	7623.529*	140	(186-100)	349	3: 150	3: 178
ART-7	29.83151	5742.964	325	(100)	152	4: 300	4: 238

FLOW1	Average extraction well flow rate for 2005 and 2006 (gallons per minute)
*	Reported flow rate for first quarter 2007
FLOW2	Calculated flow rate for simulation (cubic feet per day)
Reported K	Reported hydraulic conductivity calculated from pumping test data (feet per day)
Early ClO4	May 1998 perchlorate concentrations (mg/L; parentheses indicates data projected from nearby wells)
Late ClO4	November 2006 perchlorate concentrations (mg/L)
Initial K	Initial modeled hydraulic conductivity preceded by zone number (feet per day)
Final K	Final (computed) hydraulic conductivity preceded by zone number (feet per day)



REFERENCE	DESIGNED	BG	8/03
	DRAWN	TAD	8/03
	CHECKED		
	APPROVED		

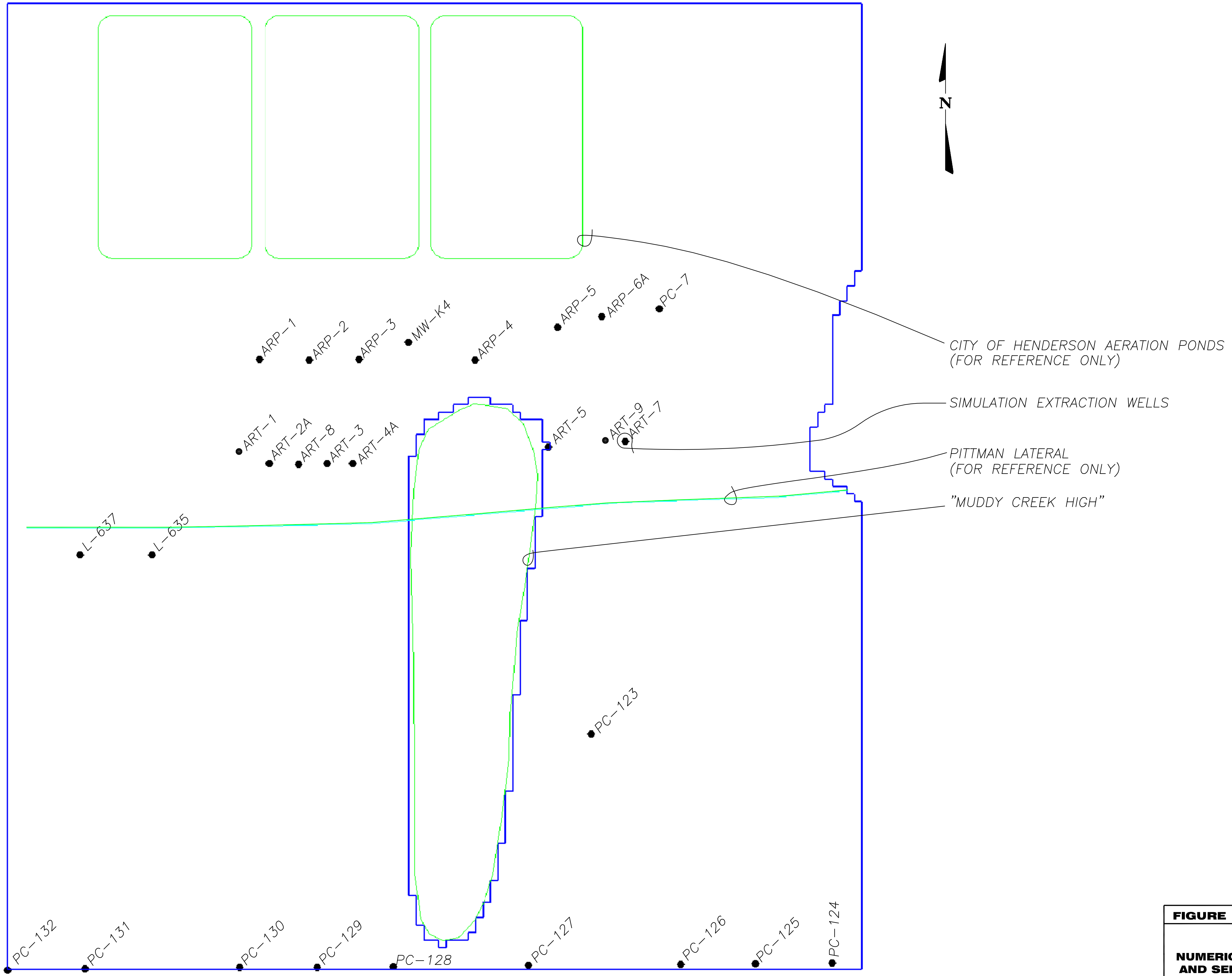
REVISIONS No.	DESCRIPTION	BY	DATE

FIGURE 1

PROJECT LOCATION MAP
-SHOWING-
ATHENS ROAD WELL FIELD
NEAR HENDERSON, NEVADA

McGinley & Associates

SCALE: AS SHOWN
REVISION A
JOB NO. BMI-009
DWG NAME BASE



0 150 300

SCALE 1" = 300'

FIGURE 2

NUMERICAL MODEL BOUNDARY AND SELECT DATA LOCATIONS

McGinley & Associates

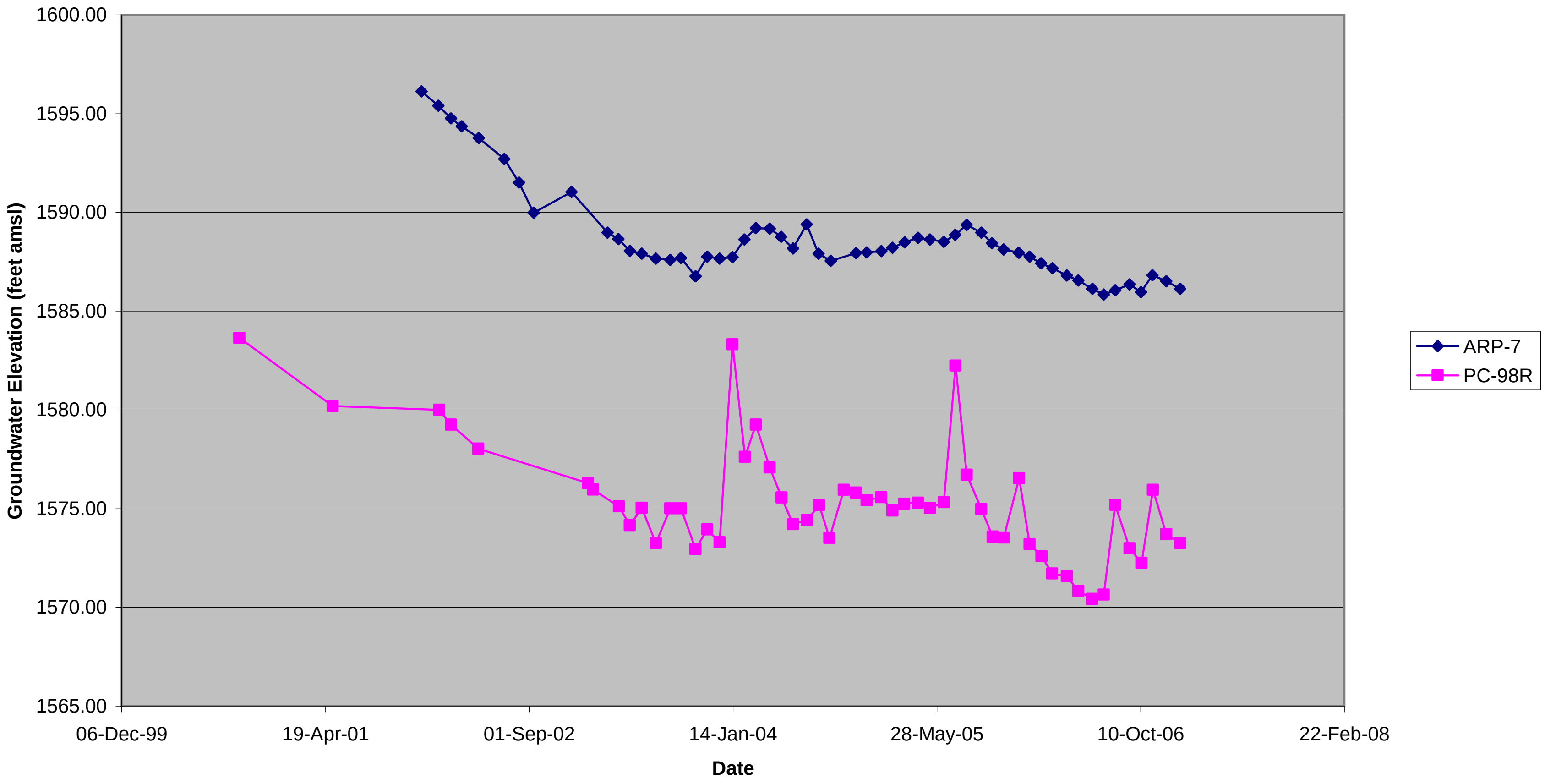
SCALE: AS SHOWN

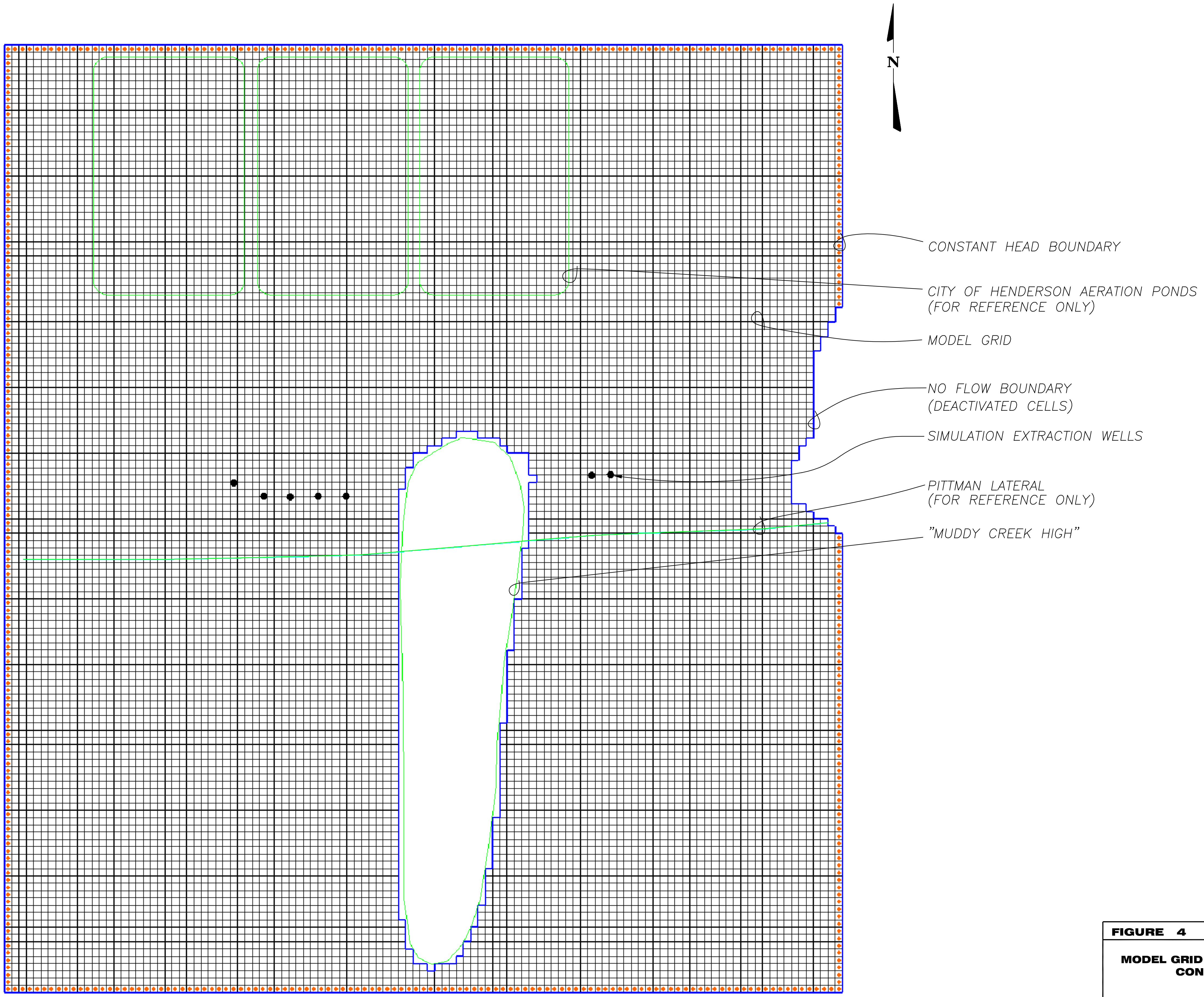
JOB NO. DEP–009

REVISION A

C:\Drafting\DEP–009\2007\FIGURES.dwg 07/17/07 22:25 TAD

Figure 3. Hydrographs for Two Wells in Vicinity of COH RIBs





0 150 300
SCALE 1" = 300'

FIGURE 4

MODEL GRID AND BOUNDARY CONDITIONS

McGinley & Associates

SCALE: AS SHOWN
JOB NO. DEP–009
REVISION
A

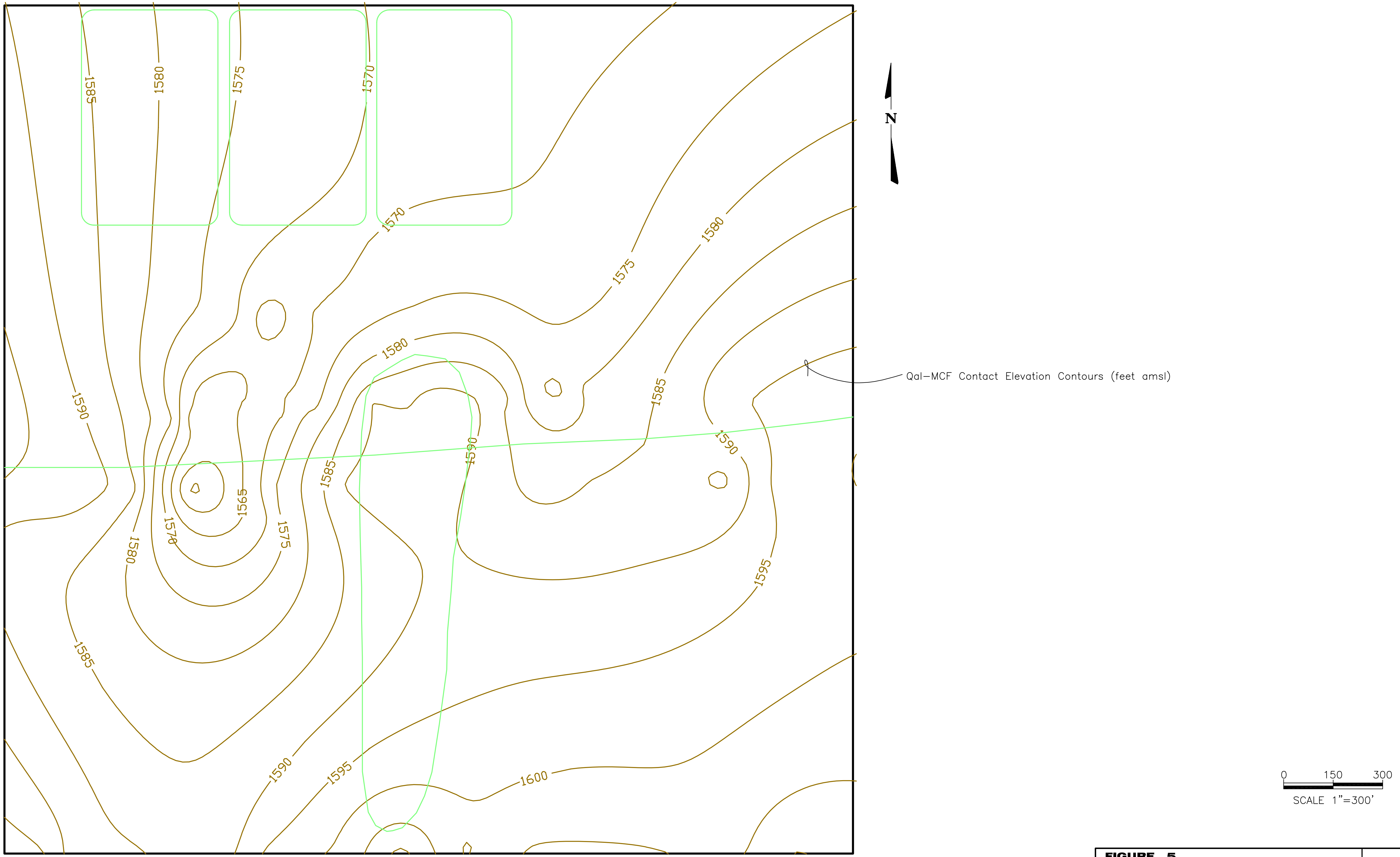


FIGURE 5

MODEL BOTTOM ELEVATION CONTOURS

McGinley & Associates

SCALE: AS SHOWN
JOB NO. DEP–009
REVISION
A

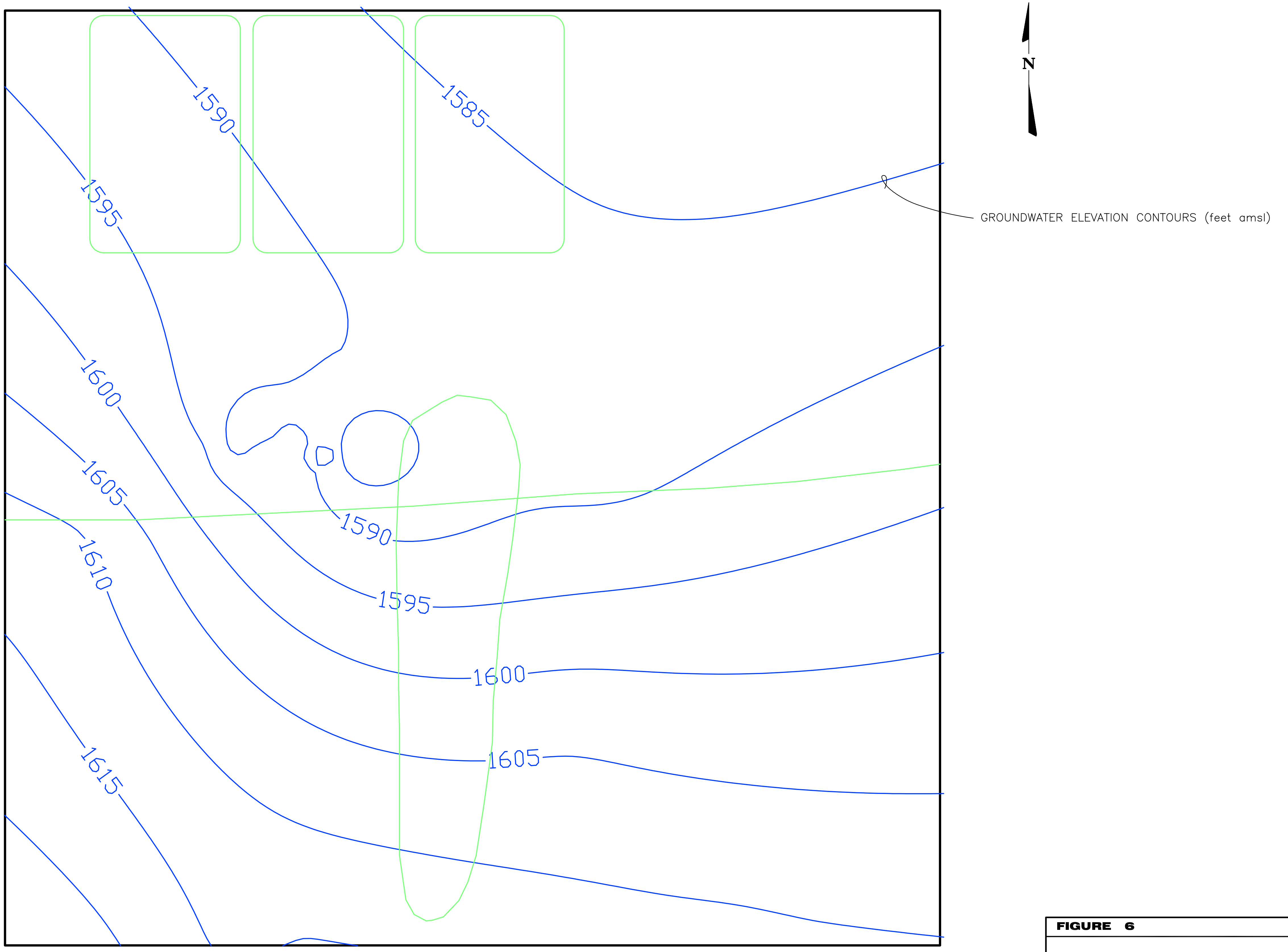


FIGURE 6

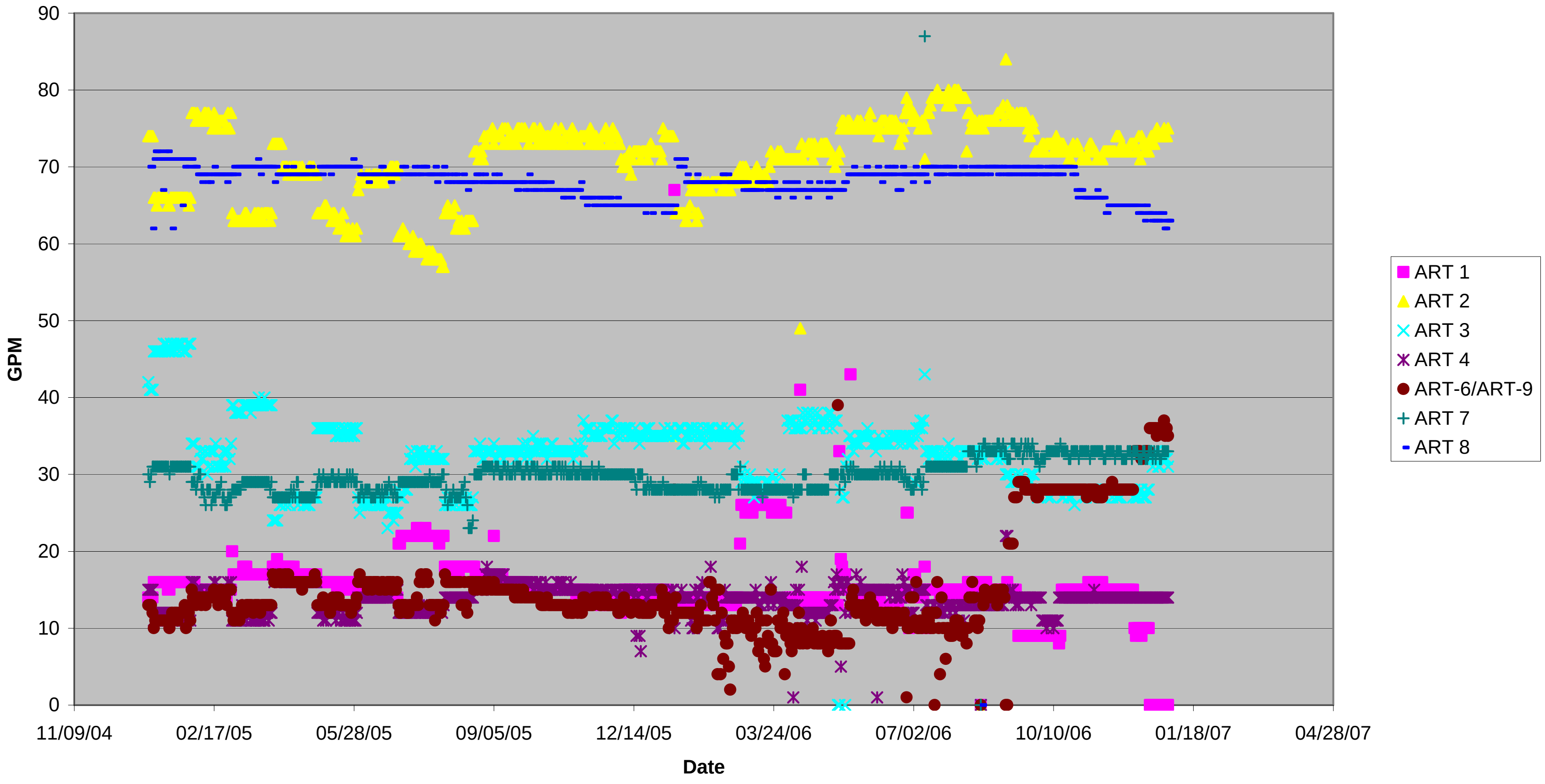
MODEL CONSTANT HEAD
BOUNDARY ELEVATION CONTOURS

McGinley & Associates

SCALE: AS SHOWN
JOB NO. DEP–009
REVISION
A

C:\Drafting\DEP–009\2007\base.dwg 07/17/07 22:23 TAD

Figure 7. ART Well Extraction Rates for 2005 and 2006



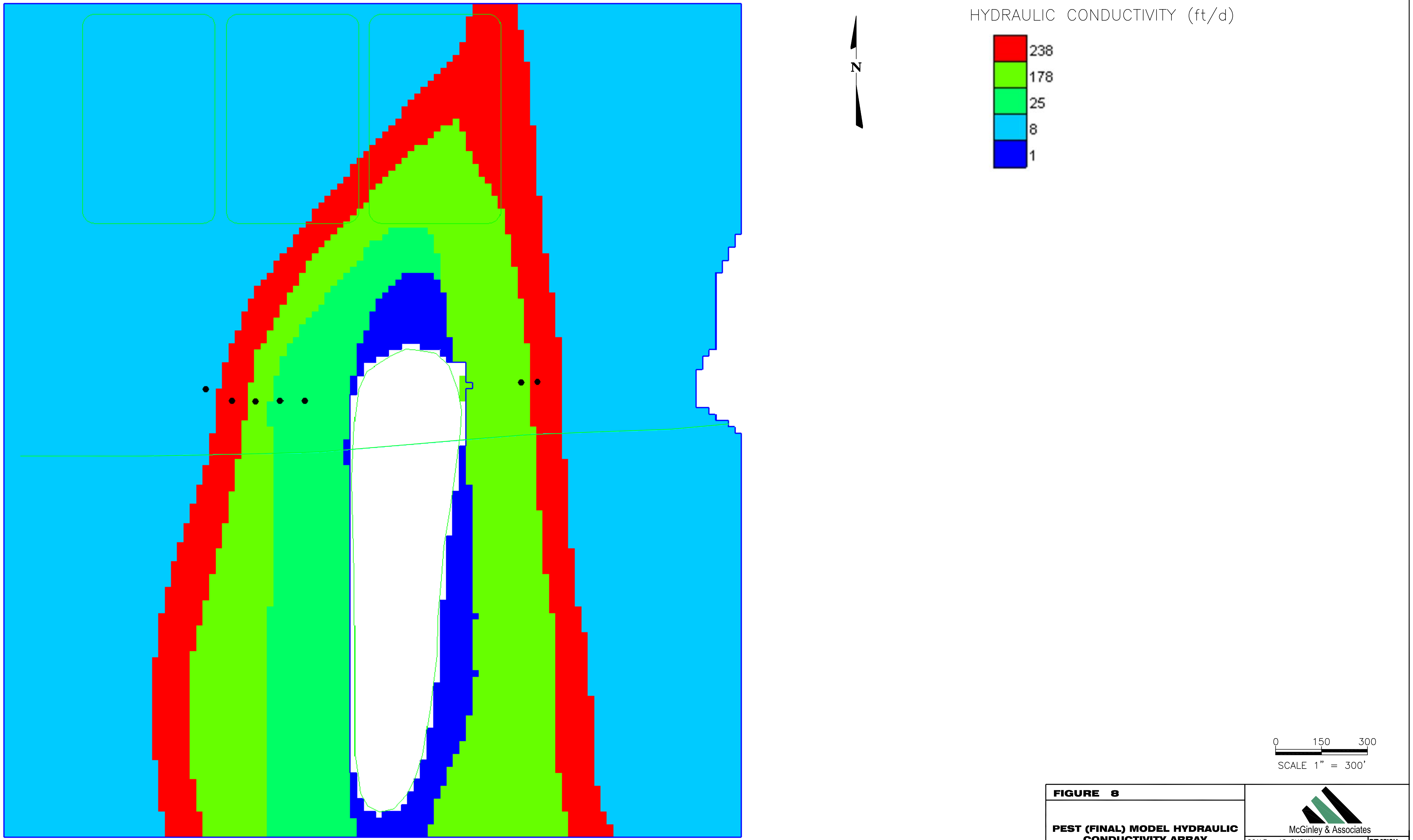


FIGURE 8

PEST (FINAL) MODEL HYDRAULIC CONDUCTIVITY ARRAY

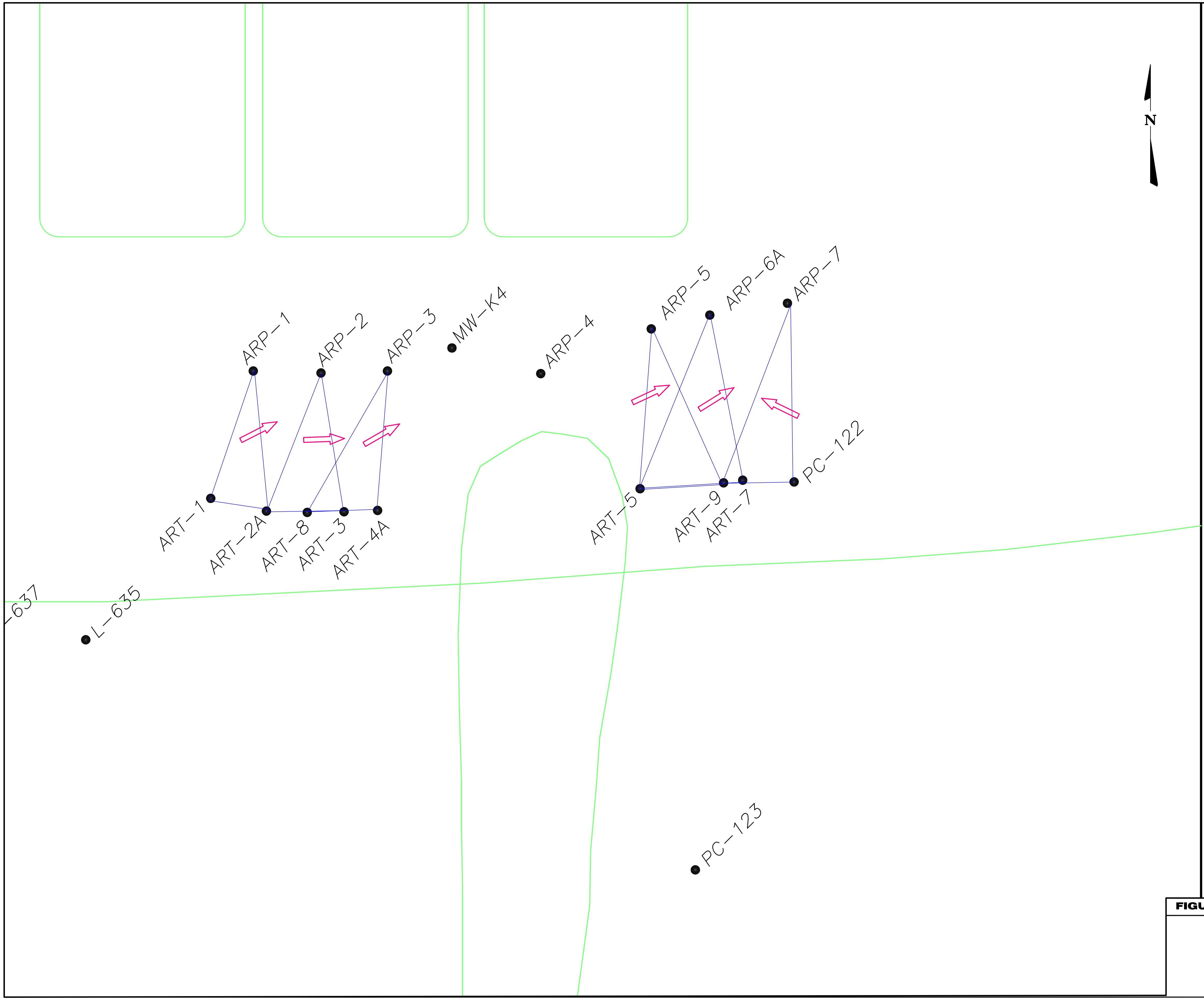
McGinley & Associates

SCALE: AS SHOWN

JOB NO. DEP-009

REVISION A

C:\Drafting\DEP-009\2007\FIGURES.dwg 07/17/07 22:53 TAD



WELL ID	GRADIENT	COMPASS BEARING
ART-1A, ART-2A, ARP-1	0.0074	63
ART-2A, ART-3, ARP-2	0.0096	88
ART-8, ART-4A, ARP-3	0.0055	60
ART-5, ART-9, ARP-5	0.0125	65
ART-5, ART-7, ARP-6A	0.0069	58
ART-9, PC-122, ARP-7	0.0091	296

LEGEND

—	WELL TRIPLET
⇦	CALCULATED GRADIENT DIRECTION

0 100 200
SCALE 1"=200'

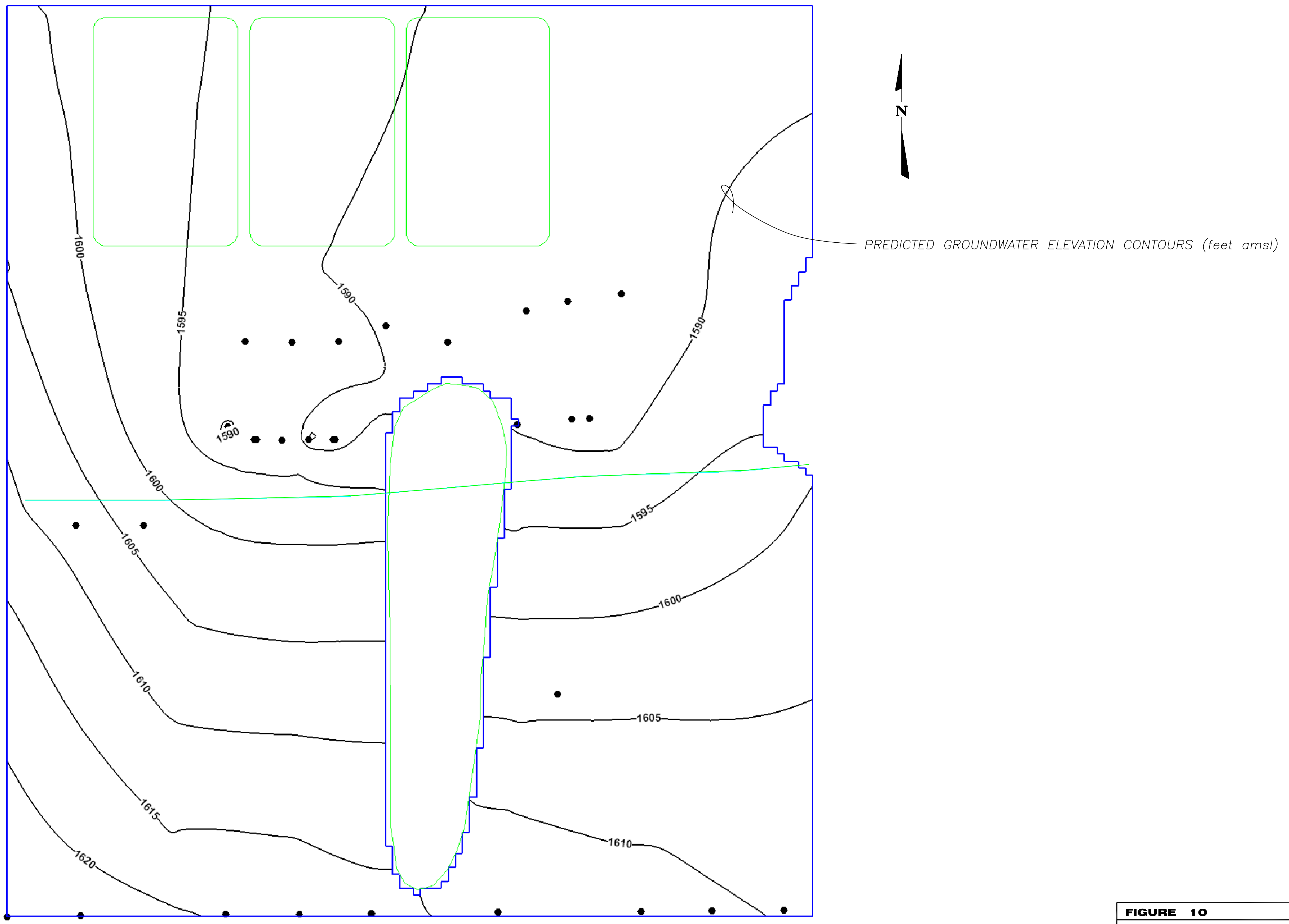
FIGURE 9

VECTORS FROM THREE POINT SOLUTIONS FOR SELECT ARF WELLS

McGinley & Associates

SCALE: AS SHOWN	REVISION
JOB NO. DEP-009	A

C:\Drafting\DEP-009\2007\DEP-009-base.dwg 07/17/07 23:04 TAD



0 150 300

SCALE 1" = 300'

FIGURE 10

PREDICTED GROUNDWATER ELEVATION CONTOURS

McGinley & Associates

SCALE: AS SHOWN

REVISION A

JOB NO. DEP-009

C:\Drafting\DEP-009\2007\FIGURES.dwg 07/17/07 22:27 TAD

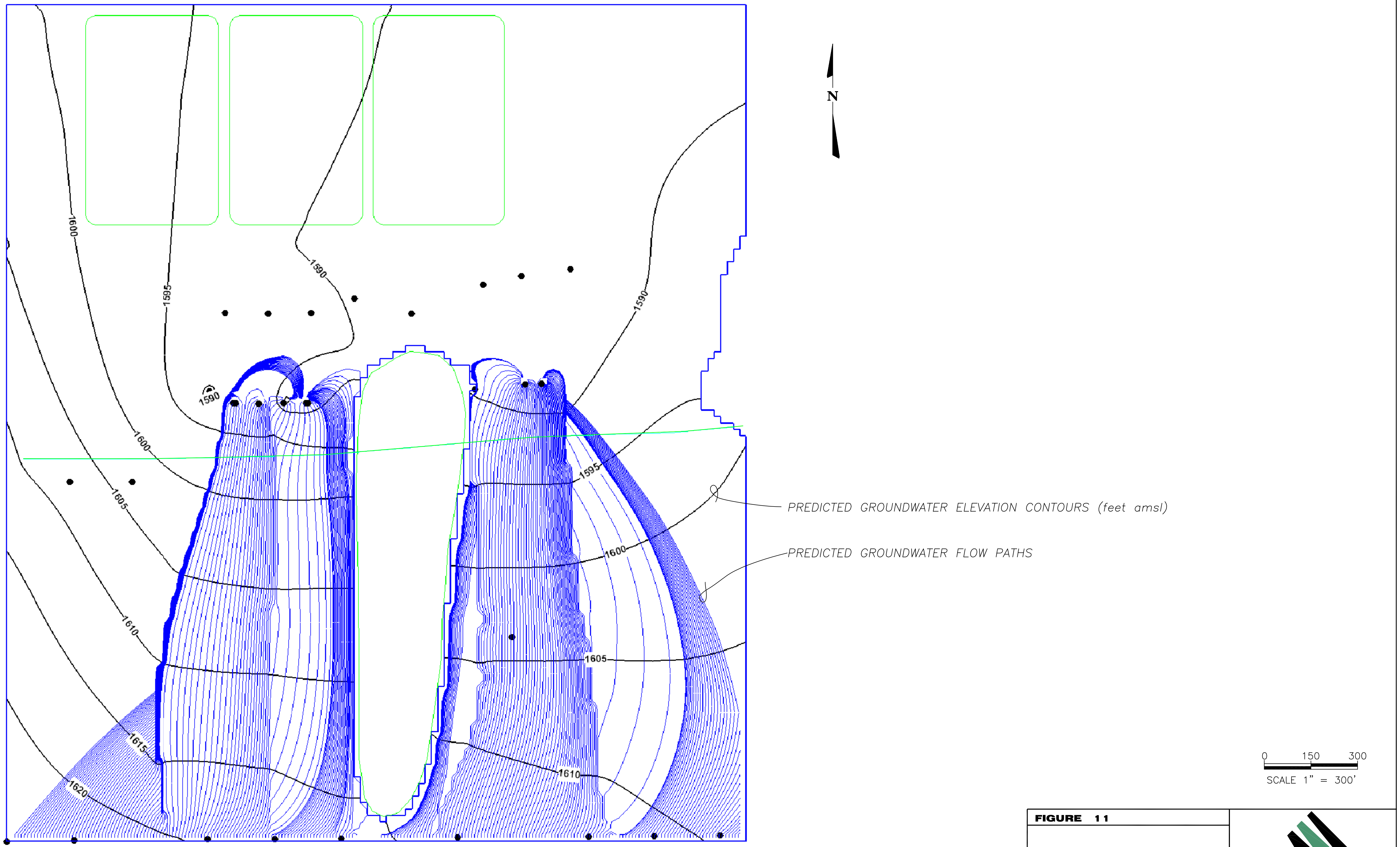


FIGURE 11

PREDICTED GROUNDWATER FLOW PATHS

McGinley & Associates

SCALE: AS SHOWN

REVISION A

JOB NO. DEP-009

C:\Drafting\DEP-009\2007\FIGURES.dwg 07/17/07 22:53 TAD

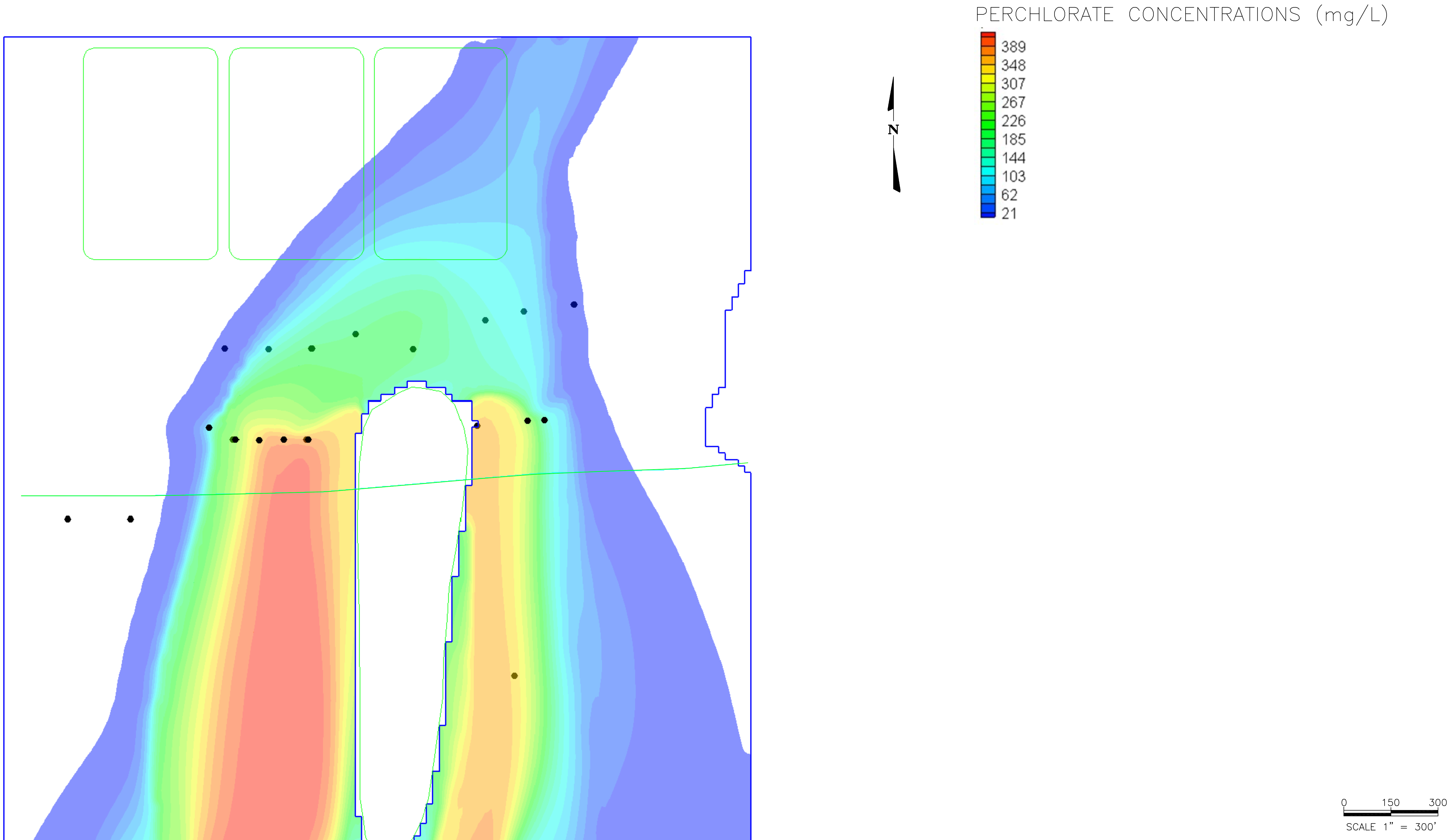


FIGURE 12

PRELIMINARY PREDICTED PERCHLORATE ISOPLETHS

McGinley & Associates

SCALE: AS SHOWN

REVISION

JOB NO. DEP-009

A

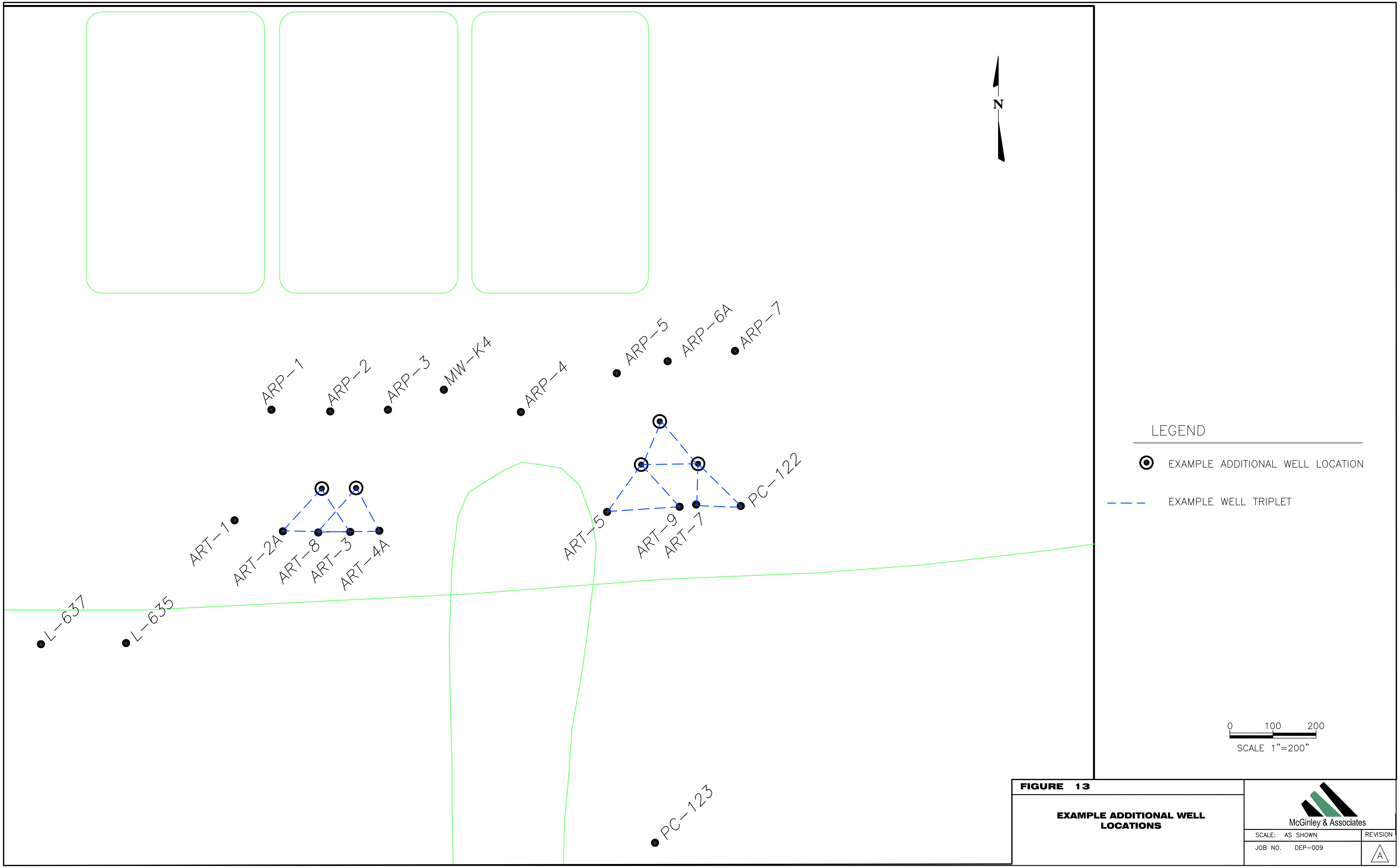


FIGURE 13

EXAMPLE ADDITIONAL WELL LOCATIONS

McGinley & Associates

SCALE: AS SHOWN

JOB NO. DEP-009

REVISION A

C:\Drafting\DEP-009\2007\base.dwg 07/17/07 23:02 TAD

APPENDIX A

Tronox Second Half 2006 Monitoring Report Figures

APPENDIX B

Project Files (Electronic)